Patent claims

1. Method for determining a deviation of at least one regulating variable on chip removal machines with a mechanical drive for a tool and/or a workpiece (1), regulated by a control system, wherein the regulation comprises a plurality of values C, X, Z of at least three spatial axes c, x, z for the control system and for the drive, and the values C, X, Z have a functional relation f_{bi} such as $Z = f_{bi}(C, X)$ with the axes c, x, z, characterized in that:

a) a protocol is prepared from a plurality of control system actual values ($C_{p,s}$, $X_{p,s}$, $Z_{p,s}$) detected by measuring means and/or selected drive actual values ($C_{p,a}$, $X_{p,a}$, $Z_{p,a}$),

b) a control system nominal value according to $Z_{bi,s} = f_{bi}(C_{p,s}, X_{p,s})$ and/or a drive nominal value according to $Z_{bi,a} = f_{bi}(C_{p,a}, X_{p,a})$ is calculated at least in relation to the z-axis,

c) and a control system differential value according to $D_{z,s} = Z_{p,s} - Z_{bi,s}$ and/or a drive differential value according to $D_{z,a} = Z_{p,a} - Z_{bi,a}$ is calculated at least in relation to the z-axis.

2. Method per claim 1, characterized in that at least for the drive and the z-axis a contouring differential value is determined according to

$$D_{z,a}^{\varphi} = Z_{p,a} - Z_{bi,a}^{\varphi}$$

with

$$Z_{bi,a}^{\varphi} = f_{bi}\,(C_{p,a} + \Delta\varphi,\, X_{p,a}),$$

where the value $\Delta\varphi$ corresponds to a phase shift of the c-axis, **which results in a torsion of the generated lens contour.**

3. Method per claim 2, characterized in that the phase shift $\Delta\varphi$ is between 0.5° and 3°, especially 1.0°, and the determination of $Z_{bi,a}^{\varphi}$ is done between + $\Delta\varphi$ and -$\Delta\varphi$ with an increment between 0.05° and 0.2°, especially 0.1°.

4. Method per one of claims 2 or 3, characterized in that one computes, at least from the differential values $D_{z,s}$, $D_{z,a}$ and/or the contouring differential values $D_{z,a}^{\varphi}$ at least for the z-axis, one peak-to-valley value for the control system according to

$$D_{z,s,ptv} = D_{z,s,max} - D_{z,s,min}$$

and for the drive according to

$$D_{z,a,ptv} = D_{z,a,max} - D_{z,a,min},$$

$$D_{z,a}^{\varphi}{}_{ptv} = D_{z,a,max}^{\varphi} - D_{z,a,min}^{\varphi},$$

where $D_{z,s/a,min}$ corresponds to the minimum and $D_{z,s/a,max}$ to the maximum differential value of the respective measurement and $D_{z,a,max}^{\varphi}$, $D_{z,a,min}^{\varphi}$ corresponds to the respective position φ, +$\Delta\varphi$ and -$\Delta\varphi$ of the c-axis, **taking into account** +/-$\Delta\varphi$.

5. Method per one of the preceding claims, characterized in that one determines an error differential value according to

$$D_{z,a}^{f} = Z_{p,a} - Z_{bi,a}^{f}$$

with

$$Z_{bi,a}^{f} = f_{bi}\ (C_{p,s}, X_{p,s})$$

at least for the drive and at least in relation to the z-axis.

6. Method per one of the preceding claims, characterized in that the function f_{bi} is a 3D bicubic surface spline and/or spiral spline.

7. Method per one of claims 4 to 6, characterized in that the differential values $D_{z,a}$, $D_{z,s}$, the contouring differential values $D_{z,a}^{\varphi}$, **the respective peak-to-valley values** $\mathbf{D_{z,s,ptv}}$, $\mathbf{D_{z,a,ptv}}$, $\mathbf{D_{z,a}^{\varphi}}_{\mathbf{ptv}}$ and/or the actual value $\mathbf{Z_{p,s}}$, $\mathbf{Z_{p,a}}$ of at least the z-axis are represented, and at least the representation of $\mathbf{D_{z,s,ptv}}$, $D_{z,a,ptv}$, and/or $D_{z,a}^{\varphi}{}_{ptv}$ is done with the smallest possible **peak-to-valley value**.

8. Method per one of claims 4 to 7, characterized in that the size and/or the deviation of at least the **peak-to-valley value** $D_{z,s,ptv}$, $D_{z,a,ptv}$, $\mathbf{D_{z,a}^{\varphi}}_{\mathbf{ptv}}$ and/or the actual value $\mathbf{Z_{p,s}}$, $\mathbf{Z_{p,a}}$ is represented in terms of the respective workpiece position.

9. Method per claim 7 or 8, characterized in that one distinguishes optically between negative (3) and positive (2) **values** when representing the differential value **and/or the contouring differential value $D_{z,a}$, $D_{z,s}$, $D_{z,a}^{\varphi}$** and/or optically in terms of the magnitude (3.1 – 3.3, 2.1 – 2.3) of the **values**.

10. Method per claim 7 or 8, characterized in that positive (2) and/or negative (3) differential values **and/or contouring differential values $D_{z,a}$, $D_{z,s}$, $D_{z,a}^{\varphi}$** are optically graduated by different color tones in terms of their magnitude (3.1 – 3.3, 2.1 – 2.3) and/or by different color tone intensities in terms of the magnitude (3.1 – 3.3, 2.1 – 2.3) of the **values**.

11. Method per one of claims 7 to 9, characterized in that one provides for a superimposed representation of the differential value **and/or the contouring differential value $D_{z,a}$, $D_{z,s}$, $D_{z,a}^{\varphi}$** and the actual value **$Z_{p,s}$, $Z_{p,a}$**, the respective scale being different for the two values.

12. Method per claim 1 to 6, characterized in that one calculates, for one or more other axes x, c, the nominal values C_{bi}, X_{bi}, the differential values $D_{x/c,a}$, $D_{x/c,s}$, the peak-to-valley value $D_{x/c,a,ptv}$, $D_{x/c,a}^{\varphi}{}_{ptv}$, $D_{x/c,s,ptv}$, $D_{x/c,s}^{\varphi}{}_{ptv}$, the error differential value $D_{x/c,a}^{f}$, $D_{x/c,s}^{f}$ and/or the contouring differential value $D_{x/c,s}^{\varphi}$, $D_{x/c,a}^{\varphi}$ for the control system and/or for the drive.

13. Method per one of claims 2 to 6 or 12, characterized in that one provides for a correction cut, in addition to a main cut and an optional precision cut during the chip removal machining of the workpiece (1), at least making use of the differential values $\mathbf{D_{z,a}}$, $\mathbf{D_{z,s}}$, $\mathbf{D_{z,a}^{\varphi}}$.

14. Method for a chip removal machine for the production of optical lenses from plastic according to one of claims 1 to 12.

15. Method per one of claims 1 or 2, characterized in that one converts the values C, X, Z of the axes c, x, z into the Cartesian system of coordinates or into the polar system of coordinates.

16. Method per one of claims 1 or 2, characterized in that one starts from a theoretical cutting point of an ideal point-like tool and convert the values C, X, Z of the axes c, x, z for use of a circular carbide tip, with the circular carbide tip having a center point corresponding to the theoretical cutting point.

17. Method per one of claims 2 to 16, characterized in that one uses at least one differential value $D_{z,a}$ and/or one contouring differential value $D_{z,a}^{\varphi}$ as an exclusion criterion for the control system's actual values ($C_{p,s}$, $X_{p,s}$, $Z_{p,s}$) and/or as an adjustment criterion for the various machine parameters and the machine's control system.

18. Chip removal machine with a mechanical drive for a tool and/or a workpiece (1), regulated by a control system, wherein the regulation comprises a plurality of values C, X, Z of at least three spatial axes c, x, z for the control system and for the drive, characterized in that a method according to one of claims 1 to 12 is used to determine the deviation of the regulating variables.

19. Chip removal machine per claim 17, characterized in that an output unit is provided for the representation of the values according to one of claims 6 to 11.